Effect of Mg^{2+} codoping on cathodoluminescence properties of Ce^{3+} activated GGAG single crystals

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High R&D activity in the field of inorganic scintillators used for ionizing radiation detection has been triggered mainly by the pressing needs of modern medical imaging, high energy physics, homeland security and environmental applications [1]. Recently, a new material concept was defined based on multicomponent $(Gd, RE)_3(Ga,Al)_5O_{12}$ host, RE=Y, Lu. Doped with Ce^{3+} and admixture with balanced Gd and Ga content host compositions showed amazingly high light yield up to 58 000 photons/MeV [2]. More recently, a strategy based on co-doping with alkali earth AE^{2+} into Ce^{3+} activated YAG [3], LuAG [5] or GGAG [5] single crystal garnet scintillators significantly improved some scintillation characteristics.

Therefore, in this work, the effect of Mg^{2+} codoping in $Gd_3Ga_{2.7}Al_{2.3}O_{12}$:Ce (GGAG:Ce) on the scintillation properties under electron beam excitation was studied. The Mg^{2+} free and Mg^{2+} codoped GGAG:Ce crystals were grown from the melt using Czochralski technique. The absorption spectra revealed the presence of both Ce^{4+} and Ce^{3+} ions in Mg^{2+} codoped sample. The RT cathodoluminescence spectra were recorded in the fast (0-32 ns) and slow (5 µs- 2 ms) gated detection mode. Scintillation decay kinetics were recorded with 250 ps time resolution and high dynamic range in a large time window (50 µs), within the 77-500 K temperature range. Finally, the defect states were investigated by thermally stimulated luminescence. The results showed that Mg^{2+} codoping leads to enormous improvement of several scintillation characteristics of investigated samples while keeping its stable scintillation efficiency up to high temperature.

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